Remarks/Arguments:

Pending Claims

Claims 1-16 are pending. Claims 17-29 have been canceled.

Applicants appreciate Examiner's allowance of claim 8.

Claims 1-6, 10-14, and 16 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Altukhov et al. (Toward $Si_{1-x}Ge_x$ Quantum-Well Resonant-State Terahertz Laser) in view of Gousev et al. (Widely Tunable Continuous-wave THz Laser). Applicants respectfully submit that claims 1-6, 10-14, and 16, as amended, are not subject to this rejection for the reason set forth below.

Altukhov et al. disclose a terahertz (THz) wave laser based on strained $Si_{1-x}Ge_x$ structures formed in thin layers with dimensions indicative of quantum-well structures. (Page 3909, last paragraph.) These layers are doped with boron. Although Altukhov et al. describe these structures as quantum-well structures, the states being utilized to achieve THz lasing are not the quantum-well sub-band states, but rather are resonant states of the acceptor levels, which are split by the strain induced by lattice mismatch between the layers. (Page 3909, fourth paragraph.) However, the thin heterogenous layers of the structure disclosed by Altukhov et al. are necessary to their device because the states used are formed by lattice mismatch strain, which decreases rapidly with distance from the interface at which the lattice mismatch occurs.

Gousev et al. disclose a terahertz (THz) wave laser based on strained bulk crystalline materials. The mechanism used, as disclosed beginning in the paragraph bridging pages 757 and 758, involves the strain-induced splitting of heavy-hole and light-hole subbands in cubic lattice crystals, such as Si and Ge and the strain-induced splitting of acceptor ground states in the crystal. Thus, uniaxial strain on a crystal lattice is necessary to provide the quantum levels utilized by Gousev et al.

Claim 1, as amended, recites at least one feature that is not disclosed or suggested by Altukhov et al. or Gousev et al., singly or in combination, namely:

> ...an unstrained bulk optical gain material formed substantially of at least one group IV element and doped with at least one dopant having an intra-center transition

> frequency in a range of about 0.3THz to 30THz;...
> (Emphasis Added)

This feature of the present invention is described in the specification at paragraph [0026].

As the Examiner states in the first full paragraph of page 3 of the Final Office Action, Altukhov et al. do not teach or suggest that intra-center transitions of a dopant in the bulk optical gain material may be used to generate THz wave radiation. Instead, they teach using resonant states of acceptor levels in thin <u>strained</u> layers of $Si_{1-x}Ge_x$ to generate THz wave radiation. Gousev et al. also use resonant states of acceptor levels in <u>strained</u> crystalline Si or Ge materials to generate THz wave radiation. The resonant states disclosed by Altukhov et al. and Gousev et al. require using <u>strained</u> crystal lattices.

Thus, one skilled in the art would not understand either Altukhov et al. or Gousev et al. to disclose a THz frequency radiation source based on <u>unstrained</u> bulk optical gain material.

In view of this deficiency, Applicants respectfully submit that claim 1, as amended, is not subject to rejection under 35 U.S.C. § 103(a) as being unpatentable over Altukhov et al. in view of Gousev et al. As claims 2-6, 10-14, and 16 depend from claim 1, these claims are not subject to this rejection as well.

Claims 1 and 7 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Pavlov et al. (<u>Stimulated Emission from Donor-Transitions in Silicon</u>, Pavlov I) in view of Altukhov et al. and Gousev et al. Applicants respectfully submit that claims 1 and 7, as amended, are not subject to this rejection for the reason set forth below.

Pavlov I discloses an optically-pumped THz wave emitter. This THz emitter uses a CO_2 laser to create an intra-center population inversion in phosphorus-doped silicon. As stated by the Examiner on page 5 of the Office Action, however, Pavlov I does not teach or suggest population inversion via electrical pumping.

The Examiner argues that Altukhov et al. and Gousev et al. teach electrically pumping a similar optical gain medium and that it, therefore, would have been obvious to one skilled in the art to modify the THz emitter of Pavlov I to be electrically pumped based on Altukhov et al. and Gousev et al.

Applicants respectfully disagree. As described above, the strained multilayer $Si_{1-x}Ge_x$ optical gain material disclosed by Altukhov et al. and the strained Si or Ge crystalline optical gain material disclosed by Gousev et al. are significantly different than the bulk optical gain material recited in claim 1, as amended, of the present application. Further, Altukhov et al. and Gousev et al. do not disclose or suggest, singly or in combination, the use of intra-center transitions to generate THz wave radiation, but rather Altukhov et al. and Gousev et al. disclose using resonant states of acceptor levels in strained crystals of Si and/or Ge to generate THz wave radiation.

Because of these differences in the optical gain material and the radiation mechanism disclosed by Altukhov et al. and Gousev et al., and those disclosed in Pavlov I, one skilled in the art would not have considered it obvious to try electrically pumping the THz emitter of Pavlov I based on the disclosure by Altukhov et al. and Gousev et al.

In view of this deficiency, Applicants respectfully submit that claim 1, as amended, is not subject to rejection under 35 U.S.C. § 103(a) as unpatentable over Pavlov I in view of Altukhov et al. and Gousev et al. As claim 7 depends from claim 1, this claim is not subject to this rejection as well.

Claims 1 and 9 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Pavlov et al. (<u>Optically Pumped Silicon Terahertz Lasers</u>, Pavlov II) in view of Altukhov et al. and Gousev et al. Applicants respectfully submit that claims 1 and 9, as amended, are not subject to this rejection for the reason set forth below.

Pavlov II discloses an optically-pumped THz wave laser based on the same optical gain material and radiation mechanism as Pavlov I. Thus, as described above, one skilled in the art would not have considered it obvious to try electrically pumping the THz laser of Pavlov II based on the disclosure by Altukhov et al. and Gousev et al.

In view of this deficiency, Applicants respectfully submit that claim 1, as amended, is not subject to rejection under 35 U.S.C. § 103(a) as unpatentable over Pavlov II in view of Altukhov et al. and Gousev et al. As claim 9 depends from claim 1, this claim is not subject to this rejection as well.

Claim 15 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over Altukhov et al. and Gousev et al. in view of Soref et al. (US 6,154,475). Applicants respectfully submit that claim 15 is not subject to this rejection for the reason set forth below.

Soref et al. disclose a THz wave laser based on strained SiGe structures formed in thin layers similar to the $Si_{1-x}Ge_x$ structures disclosed by Altukhov et al.

Like Altukhov et al. and Gousev et al., Soref et al. do not teach or suggest the use of intra-center transitions of a dopant in an unstrained bulk optical gain material to generate THz wave radiation. Thus, Soref et al. cannot make up for the deficiencies of Altukhov et al. and Gousev et al. that are described above with respect to claim 1 of the present application, as amended.

Therefore, Applicants respectfully submit that claim 1, as amended, is not subject to rejection under 35 U.S.C. § 103(a) as unpatentable over Altukhov et al. and Gousev et al. in view of Soref et al. As claim 15 depends from claim 1, this claim is not subject to this rejection as well.

Newly Added Claims

Claims 30-33 have been added. Claim 30 is independent and claims 31-33 depend from claim 30.

Support for claim 30 may be found in the specification at paragraph [0026]. Claims 31-33 include features recited in original claims 2, 3, and 9 respectively.

Applicants respectfully submit that, because the resonant states disclosed by Altukhov et al. and Gousev et al. require strain in crystal lattices that do not exist in amorphous bulk materials, one skilled in the art would not understand either Altukhov et al. or Gousev et al. to teach or suggest the use of bulk amorphous optical gain material, as recited in new independent claim 30.

In view of this deficiency, Applicants respectfully submit that claims 30-33 are in condition for allowance.

Conclusion

In view of the foregoing amendments and remarks, Applicants request that the Examiner reconsider and withdraw the rejections and objections of claims 1-7 and 9-16, and that the Examiner consider and allow newly added claims 30-33.

Respectfully submitted,

Stephen J. Weed, Reg. No. 45,202
Lowell L. Carson, Reg. No. 48,548
Attorneys for Applicants

SJW/LLC/ks

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